Record Types

```
{- name="Jones", salary=20300, age=26};

val it =
{age = 26, name = "Jones", salary = 20300}
: {age : int, name : string, salary : int}


- {1="Jones", 2=20300,3=26};

> val it = ("Jones", 20300, 26)
           : string * int * int
```

Record Pattern Matching

```
- val emp1 =
{name="Jones", salary=20300, age=26};

> val emp1 =
{age = 26, name = "Jones", salary = 20300}
: {age : int, name : string, salary : int}

- val {name=n1,salary=s1,age=a1}= emp1;

> val n1 = "Jones" : string
  val s1 = 20300 : int
  val a1 = 26 : int

- val {name=n1,salary=s1,...} = emp1;

> val n1 = "Jones" : string
  val s1 = 20300 : int

- val {name,age,...} = emp1;

> val name = "Jones" : string
  val age = 26 : int
```

Record Types

```
type employee = {name: string,
                 salary: int,
                 age: int};
```

```
> type employee
```

```
fun tax (e: employee) =
          real(#salary e)*0.22
```

Or,

```
fun tax ({salary,...}: employee) =
        real(salary)*0.22;
```

Enumerated Types

Consider the King and his court:

```
datatype degree = Duke
                | Marquis
                | Earl
                | Viscount
                | Baron;

datatype person =
            King
          | Peer of degree*string*int
          | Knight of string
          | Peasant of string;
```

All constructors are distinct.

Functions on Datatypes

```
[King,
 Peer(Duke, "Gloucester", 5),
 Knight "Gawain",
 Peasant "Jack Cade"];
```

```
val it  = ... : person list
```

```
fun superior (King, Peer _) = true
  | superior (King, Knight _) = true
  | superior (King, Peasant _) = true
  | superior (Peer _,Knight _) = true
  | superior (Peer _, Peasant _) = true
  | superior (Knight _, Peasant _) = true
  | superior _ = false;
```

Exceptions

Exceptions are raised when there is no matching pattern, when an overflow occurs, when a subscript is out of range, or some other run-time error occurs.

Exceptions can also be explicitly raised.

```
exception Failure;
exception BadVal of Int;
```

```
raise Failure
raise (BadVal 5)
```

E `handle` P_1 `=>` E_1 `|` ... `|` P_n `=>` E_n

Recursive Datatypes

The built-in type operator of lists might be defined as follows:

```
 infix :: ;

 datatype 'a list = nil
                  | :: of 'a * 'a list;
```

Binary Trees:

```
datatype 'a tree =
            Lf
          | Br of 'a * 'a tree * 'a tree;
```

```
 Br(1, Br(2, Br(4, Lf, Lf),
             Br(5, Lf, Lf)),
       Br(3, Lf, Lf))
```

Functions on Trees

Counting the number of branch nodes

```
fun count Lf              = 0
  | count (Br(v,t1,t2)) =
           1+count(t1)+count(t2);
```

```
val count = fn : 'a tree -> int
```

Depth of a tree

```
fun depth Lf              = 0
  | depth (Br(v,t1,t2)) =
          1+Int.max(depth t1, depth t2);
```

```
val depth = fn : 'a tree -> int
```

Listing a Tree

Three different ways to list the data elements of a tree

Pre-Order

```
fun preorder Lf              = []
  | preorder (Br(v,t1,t2))=
     [v] @ preorder t1 @ preorder t2;
```

In-Order

```
fun inorder Lf              = []
  | inorder (Br(v,t1,t2))=
     inorder t1 @ [v] @ inorder t2;
```

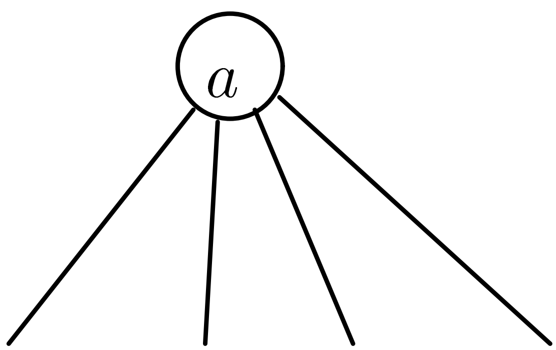
Post-Order

```
fun postorder Lf              = []
  | postorder (Br(v,t1,t2))=
     postorder t1 @ postorder t2 @ [v];
```

Multi-Branching Trees

To define a datatype of a tree where each node can have any number of children

```
datatype 'a mtree =
        Branch of 'a * ('a mtree) list;
```



To recursively define functions, we can use `map`.

```
fun double (Branch(k,ts)) =
          Branch(2*k, map double ts);
```