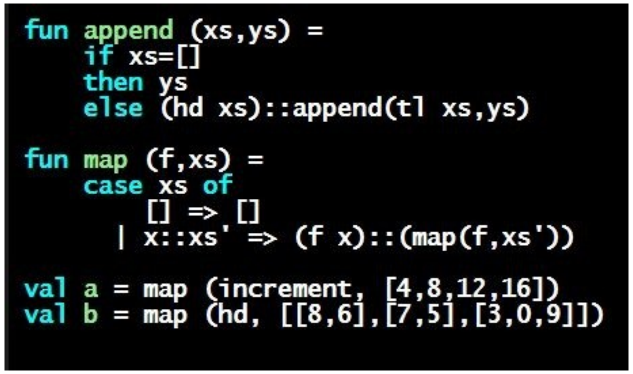

```
fun append (xs,ys) =
    if xs=[]
    then ys
    else (hd xs)::append(tl xs,ys)

fun map (f,xs) =
    case xs of
        [] => []
      | x::xs' => (f x)::(map(f,xs'))

val a = map (increment, [4,8,12,16])
val b = map (hd, [[8,6],[7,5],[3,0,9]])
```

Programming Languages

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ML Expressions and Variable Bindings

Mindset

- “Let go” of all programming languages you already know

- For now, treat ML as a “totally new thing”
  - Time later to compare/contrast to what you know
  - For now, “oh that seems kind of like this thing in [Java]” will confuse you, slow you down, and you will learn less

- Start from a blank file…

A very simple ML program

[The same program we just wrote in Emacs; here for conveniene if reviewing the slides]

```
(* My first ML program *)

val x = 34;

val y = 17;

val z = (x + y) + (y + 2);

val q = z + 1;

val abs_of_z = if z < 0 then 0 - z else z;

val abs_of_z_simpler = abs z
```

A variable binding

```
val z = (x + y) + (y + 2); (* comment *)
```

More generally:

```
val x = e;
```

- *Syntax*:
  - *Keyword* `val` and *punctuation* = and `;`
  - *Variable* `x`
  - *Expression* `e`
    - Many forms of these, most containing *subexpressions*

The semantics

- Syntax is just how you write something
- Semantics is what that something means
  - Type-checking (before program runs)
  - Evaluation (as program runs)
- For variable bindings:
  - Type-check expression and extend static environment
  - Evaluate expression and extend dynamic environment

So what is the precise syntax, type-checking rules, and evaluation rules for various expressions? Good question!